21. In a mass-spring system, the displacement of the vibrating mass is:

    $x = 0.75\cos(5.6t)$ meter.

    The mass attached is 0.8 kg. Find the

    (a) amplitude of vibration
    (b) frequency of vibration
    (c) the force constant of the spring
    (d) the total energy of the system
    (e) potential energy and speed at $T = 2$ s.

22. A scale in a fish market vibrates at 2.5 Hz when a fish of mass 1.5 kg is placed on it. What is the spring constant?

23. A scale in the supermarket stretches 5 cm from its relaxed position when vegetables of mass 0.75 kg are placed on it. What will be the frequency of vibration if 1.0 kg of potatoes are placed on it and removed?

24. You hear a thunder clap 15 s after you see lightning on a stormy night. The average speed of the sound wave in the air is 343 m/s. How far are you from the lightning stroke? The speed of light is 3×10^8 m/s.

25. Calculate the power level of a sound in decibels (dB) if the intensity of the sound is 5 microwatt/m^2.

26. The density of aluminum is 2.7×10^3 kg/m^3 and its Young's modulus is 7×10^{10} N/m^2. Find the speed of sound in the aluminum.

27. The sound level of a vacuum cleaner is listed as 50 dB. What will be its intensity in W/m^2?

28. In a firework display, an observer hears the sound of explosion from an exploding rocket 500 m away. What is the time after the explosion that the observer will hear it? The temperature of the air is 15°C.

29. A physicist at a rock concert 25 m from the audio speaker finds the sound level to be 100 dB. How should he advise others if they wanted to hear no less than 80 dB of music from the same speaker? Ignore absorption of sound in the air.

30. Sound waves at a frequency of 975 Hz are emitted uniformly in all directions. An observer sitting 3 m from the source measures a loudness level of 36 dB. Calculate the power of sound at the emitting source.

31. The engine of a commuter train moving at 20 m/s, sounds its horn at a frequency of 375 Hz. What will be the frequency observed by a person standing on the station platform if the train is,

    (a) approaching the observer?
    (b) receding from the observer?
    The speed of sound is 341 m/s.

32. A police car moving at 90 mph starts chasing a speeding car with its siren set at 1,500 Hz. The driver of the speeding car measures the frequency of the siren to be 1,850 Hz. If the speed limit is 65 mph, was the driver speeding? Speed of sound is 341 m/s.

ANSWERS: 21. a 0.75m b 0.89 Hz c. 25.1 N/m d. 7.1 J e. 4.13 m/s 22. 370.1 N/m 23. 1.93 Hz

✔ Check Yourself

1. (a) Time period,

    $$T = \frac{1}{f}, \quad f = 4.7 \times 10^{14}\,Hz$$

    $$T = \frac{1}{4.7 \times 10^{14}} = 2.13 \times 10^{-15}\,s$$

    (b) Speed, $v = \lambda f$